

WE CLAIM:

1. A pultruded part of constant transverse, predetermined cross-sectional shape and formed by a pultrusion die comprising:

5 a stretch of elongated fiber rovings;

an elongated reinforcement mat associated with the stretch of fiber rovings, said reinforcement mat including

a first layer of generally longitudinally-extending fibers which provide longitudinal strength to the mat;

10 a second layer of generally transverse reinforcement fibers in association with the first layer of generally longitudinal fibers and oriented in a direction at an angle with respect to the longitudinal pull direction of the mat to provide transverse strength to the mat;

15 a third layer of diagonal transport fibers for the transverse reinforcement fibers, said transport fibers extending diagonally of the first layer of generally longitudinally-extending fibers in directions to provide shear strength stiffness and anti-skewing resistance to the mat;

20 a batting layer containing fibers, at least a portion of which extend through the thickness of the mat layers and interconnect the fibers of the layers to increase the shape-retaining capability of the mat during pultrusion of the part; and

a synthetic resin composition enveloping said mat and the elongated fiber rovings and configured to present said predetermined desired cross-sectional shape of the part.

25 2. A pultruded part as set forth in claim 1 wherein at least a portion of the fibers of the batting layer which extend through and interconnect the mat layers are entangling fibers.

30 3. A pultruded part as set forth in claim 2 wherein the entangling fibers have a bending resistance less than that of the fibers of the first and second layers.

4. A pultruded part as set forth in claim 2 wherein the entangling fibers include a certain proportion of fibers having a lower melting temperature than a remaining proportion of entangling fibers, said low-melt fibers being bonded to the fibers of the first and second layers.

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5. A pultruded part as set forth in claim 1 wherein the generally transverse fibers of the reinforcement layer are disposed at an angle of about 60° to about 90° with respect to the longitudinal length of the fibers of said first layer.

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6. A pultruded part as set forth in claim 1 wherein the generally transverse fibers of the reinforcement layer are disposed at an angle of about 90° with respect to the longitudinal length of the fibers of said first layer.

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7. A pultruded part as set forth in claim 1 wherein the fibers of said third transport layer are disposed at an angle in the range of about $+30^{\circ}$ to about $+60^{\circ}$ and from about -30° to about -60° with respect to the longitudinal length of the fibers of the first layer.

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8. A pultruded part as set forth in claim 1 wherein is provided a third layer of fibers for transporting the transverse fibers of the second layer, said third layer being provided with first transport fibers disposed at an angle of about $+45^{\circ}$ and second transport fibers are disposed at an opposite angle of about -45° with respect to the longitudinal length of the fibers of the first layer.

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9. A pultruded part as set forth in claim 1 wherein is provided a network of flexible stitching joining and interconnecting at least certain layers of the mat.

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10. A pultruded part as set forth in claim 1 wherein is provided a series of individual, spaced, generally tubular areas extending through the layers of the mat, said areas being filled with a resin which thereby increases the reinforcement properties of the mat.

11. A pultruded part as set forth in claim 1 wherein said part is a fenestration component selected from the group of window jambs, sills, heads, sash stiles and sash rails.

12. A pultruded part as set forth in claim 11 wherein said mat is adjacent the normally outermost surface of said component.

13. A mat for use as reinforcement for a resin composition to be used in forming an elongated, pultruded part of constant transverse cross-section using a pultrusion die, said mat comprising:

a first layer of continuous, generally longitudinally-extending fibers which provide longitudinal strength to the mat;

a second layer of generally transverse reinforcement fibers in association with the first layer of generally longitudinal fibers and oriented in a direction at an angle with respect to the longitudinal pull direction of the mat to provide transverse strength to the mat;

a third layer of diagonal transport fibers for the transverse reinforcement fibers, at least certain of the transport fibers extending diagonally of the first layer of generally longitudinally-extending fibers and oriented to provide shear strength stiffness and anti-skewing resistance to the mat; and

a batting layer containing fibers, at least a portion of which extend through the thickness of the mat layers and interconnect the fibers of all of the layers to increase the shape-retaining capability of the mat during pultrusion of the part.

14. The mat of claim 13 wherein said batting layer is bonded to the other layers of the mat forming a monolithic body.

15. The mat of claim 13 wherein is provided a binding agent which bonds the mat layers into a monolithic body.

16. The mat of claim 13 wherein at least a portion of the batting layer fibers extend through the thickness of the mat layers and which extend through and interconnect the mat layers, are entangling fibers.

5 17. The mat of claim 16 wherein the entangling fibers are formed of a cut-staple material.

18. The mat of claim 16 wherein the fibers of the first layer are formed of glass and the entangling fibers are of a synthetic resin polymer.

10 19. The mat of claim 16 wherein at least certain of the entangling fibers are heat bonded to the fibers of the other layers of the mat.

15 20. The mat of claim 13 wherein a first portion of the transport layer fibers extend diagonally from one side of the mat to the other side and a second portion of the transport layer fibers extend diagonally from said other side to said one side.

20 21. The mat of claim 20 wherein the angle of the fibers of the first and second portions of the transport layer with respect to the longitudinally-extending fibers of the first layer is essentially the same.

25 22. The mat of claim 21 wherein the fibers of each of the first and second portions lie along respective straight lines at a common angle with respect to the line of the pull of the mat.

23. The mat of claim 13 wherein the fibers of said third transport layer are disposed at an angle in the range of about + 30° to about + 60° and from about - 30° to about - 60° with respect to the longitudinal length of the fibers of the first layer.

24. The mat of claim 23 wherein the transport layer of fibers extend at opposite angles of about $+45^\circ$ and about -45° with respect to the longitudinally-extending fibers of the first layer.

5 25. The mat of claim 13 wherein the transverse reinforcement mat fibers are oriented in a direction at an angle of from about 60° to about 90° with respect to the longitudinally-extending fibers of the first layers.

10 26. The mat of claim 25 wherein the transverse reinforcement mat fibers are oriented in a direction at an angle of about 90° with respect to the longitudinally-extending fibers of the first layers.

15 27. A mat for use as reinforcement for a resin composition to be used in forming an elongated, pultruded part of constant transverse cross-section using a pultrusion die, said mat comprising:

a first layer of continuous, generally longitudinally-extending fibers which provide longitudinal strength to the mat;

20 a second layer of generally transverse reinforcement fibers in association with the first layer of generally longitudinal fibers and oriented in a direction at an angle with respect to the longitudinal pull direction of the mat to provide transverse strength to the mat; and

25 a batting layer containing fibers, at least a portion of which extend through the thickness of the mat layers and interconnect the fibers of all of the layers to increase the shape-retaining capability of the mat during pultrusion of the part, the batting layer being bonded to the other layers of the mat.

28. The mat of claim 27 wherein the generally longitudinally-extending fibers of the first layer includes fibers which extend at an angle of from about 0° to about $+20^\circ$ and from about 0° to about -20° relative to the direction of the pull of the mat.

29. A method of preparing a mat for use as reinforcement for a resin composition to be used in forming an elongated, pultruded part of constant transverse cross-section using a pultrusion die, said method comprising:

providing a first layer of generally longitudinally-extending fibers which provide longitudinal strength to the mat;

providing a second layer of generally transverse reinforcement fibers in association with the first layer of generally longitudinal fibers and oriented in a direction at an angle with respect to the longitudinal pull direction of the mat to provide transverse strength to the mat;

providing a third layer of transport fibers for the transverse reinforcement fibers, at least certain of the transport fibers extending diagonally of the first layer of generally longitudinally-extending fibers and oriented to provide shear strength and anti-skewing resistance to the mat;

providing a batting layer containing plurality of fibers; and

directing at least a portion of the batting layer fibers through the thickness of the layers to interconnect the fibers of the layers to increase the shape-retaining capability of the mat during pultrusion of a part.

30. The method of claim 29 wherein is included the step of providing a second layer of generally transverse reinforcement fibers in which the transverse fibers are oriented at an angle of from about $\pm 60^\circ$ to about 90° .

31. The method of claim 29 wherein is included the step of providing a third layer of transport fibers in which there are transport fibers at an angle of from about $+30^\circ$ to about $+60^\circ$ and from about -30° to about -60° .

32. The method of claim 29 wherein is included the step of providing a third layer of transport fibers in which there are transport fibers at an angle of about $+45^\circ$ and about -45° .

33. The method of claim 29 wherein the fibers, at least a portion of which extend through the thickness of the mat layers and extend through and interconnect the mat layers, are entangling fibers, and including the step of providing entangling fibers, at least certain of which have a lower melting temperature than other entangling fibers such that the lower melting fibers are bonded to the pull layer fibers and the angular mat fibers of the reinforcement layer during pulling of the pultruded part through the pultrusion die.

34. The method of claim 29 wherein is included the step of providing entangling fibers which extend through the thickness of the mat layers.

35. The method of claim 34 wherein said step of providing entangling fibers includes providing B-stage thermoset or thermoplastic fibers.

36. The method of claim 34 wherein said entangling fibers are a polyester terephthalate.

37. The method of claim 29 which includes applying forces to the mat layers which deflect at least certain of the fibers of said reinforcement layer to provide said entangling fibers.

38. The method of claim 37 which includes applying forces generally normal to the reinforcement layer for deflecting fibers thereof to produce said entangling fibers.

39. The method of claim 37 which includes applying water-jets in a direction generally normal to the reinforcement layer to produce said entangling fibers.

40. The method of claim 37 which includes subjecting the fibers of the reinforcement layer to hydraulic forces from a hydro-entangler to produce said entangling fibers.

41. The method of claim 40 which includes subjecting the fibers of the reinforcement layer to hydraulic forces within the range of about 600 psi to about 1200 psi to produce said entangling fibers.

5 42. The method of claim 29 wherein is included the steps of heat binding the fibers of the layers of the mat to one another.

43. The method of claim 29 which includes providing a first portion of transport fibers which extend diagonally from one side of the mat to the other side and a second portion
10 of reinforcement fibers which extend diagonally from said other side to said one side.

44. The method of claim 43 wherein the angle of the first and second portions of the reinforcement fibers is essentially the same.

15 45. The method of claim 29 which includes the steps of providing glass longitudinally-extending fibers in said first layer and synthetic resin fibers in said second layer.

46. The method of claim 29 wherein is included the step of providing random-oriented fibers presenting a flexible, relatively thin batting layer.

20 47. The method of claim 29 wherein is provided stitching for interconnecting the mat layers.

48. The method of claim 47 wherein said stitching comprises a polyester thread.

25 49. The method of claim 29 wherein is included the step of providing a synthetic resin coating on at least certain of the fibers of the reinforcement layer.

50. The method of claim 49 wherein said synthetic resin coating is a resin selected
30 from the group consisting of amid and polyester resins capable of softening and bonding the mat layers.

51. The method of claim 29 wherein is included the step of providing an array of spaced holes extending through at least certain of the layers of the mat.

52. The method of claim 51 wherein said holes number from 1 to 5,000 per square
5 inch.

53. The method of claim 51 wherein said holes are selected from the group of round, polygonal or pin holes.

10 54. The method of claim 53 wherein said holes are arranged in pattern orientations selected from the group of relatively close-packed random, circular, square, rectangular, or hexagonal.

15 55. The method of claim 29 wherein is included the step of providing a batting layer in which the fibers thereof comprise polyester fibers.

20 56. The method of claim 29 wherein is included the step of providing a quantity of synthetic resin in association with at least certain of the fibers of the layers of the mat and comprising a polyvinyl acetate-based binder.

57. The method of claim 56 wherein is included the step of thermally bonding the layers of said mat together by use of said quantity of said synthetic resin associated with at least certain of the fibers.

25 58. The method of claim 57 wherein said quantity of synthetic resin in association with at least certain of the fibers is selected from the group consisting of a powder, solvent, thermal or aqueous-based thermoplastic binder.

30 59. The method of claim 29 where the entire mat thickness is no more than about .020 in.

60. The method of claim 29 wherein is included the steps of folding the edges of the mat over to form a hem defining added longitudinal fibers to reinforce the edges of the mat.

61. The method of claim 29 wherein is included the step of providing entangling
5 fibers having a bending resistance less than that of the fibers of the first and second layers.

62. A method of preparing a mat for use as reinforcement for a resin composition to be used in forming an elongated, pultruded part of constant transverse cross-section using a pultrusion die, said method comprising:

10 providing first and second mat layers of fibers, said layers being arranged in opposite, substantially equal angular directions greater than 0° and no more than $+20^\circ$ and -20° less with respect to the pull direction of the mat during pultrusion of the part in disposition to provide longitudinal strength;

15 providing a third layer of generally transverse reinforcement fibers in association with the first and second mat layers, the fibers of said third layer being oriented in a direction at an angle with respect to the longitudinal pull direction of the mat to provide transverse strength to the mat; and

20 providing a batting layer containing fibers at least a portion of which comprise entangling fibers extend through the thickness of the mat layers and interconnect the fibers of the layers.

63. The method of claim 62 wherein the fibers of said first and second mat layers each lie in essentially a straight line at a common angle respectively relative to the line of pull.

25 64. The method of claim 62 wherein is provided a binder bonding the layers of the mat together.

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